GEOTECHNICAL INVESTIGATION
MCMILLAN PROPERTY
APPROXIMATELY 12200 SOUTH THUNDER ROAD
RIVERTON, UTAH

Project No. 1508-11

To

Mr. Vic Barnes
Peterson Development
225 South 200 East
Salt Lake City, Utah 84117

May 2004

Mr. Vic Barnes
Peterson Development
225 South 200 East #300
Salt Lake City, UT 84111

May 18, 2004
1508-11geo

SUBJECT: Geotechnical Investigation
McMillan Property
Approximately 12200 South Thunder Road
Riverton, Utah

In accordance with your request, we have performed a geotechnical investigation for the McMillan Property located at approximately 12200 South Thunder Road in Riverton. The accompanying report presents the results of our field investigation and engineering analysis. The soil and foundation conditions are discussed and recommendations for the geotechnical engineering aspects of the site development are presented.

This report is prepared for the sole benefit of Peterson Development and may not be relied upon by any other person or entity without the written authorization of Wasatch Environmental, Inc. Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical and environmental engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied.

If you have any questions concerning our findings, please call.

Sincerely,

WASATCH ENVIRONMENTAL, INC.

Les Pennington, P.E.
President

LP/ww

Copies: (3) Addressee

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GEOTECHNICAL INVESTIGATION
MCMILLAN PROPERTY
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RIVERTON, UTAH

1. INTRODUCTION

In this report we present the results of our geotechnical investigation for the McMillan Property located at approximately 12200 South Thunder Road in Riverton, Utah. The purpose of the geotechnical investigation was to evaluate the subsurface soil conditions at the site and to provide recommendations concerning the soil and foundation engineering aspects of the proposed development.

2. SCOPE

The scope of work performed in this investigation included a site reconnaissance, subsurface exploration, engineering analysis of the field data, and the preparation of this report. The data obtained and the analyses performed were for the purpose of providing design and construction criteria for site earthwork, building foundations, and slab-on-grade construction. It is our understanding the site will be developed into single family lots.

3. SITE CONDITIONS

3.1 Surface

The site is approximately 15.8 acres in plan dimension. The property has an elevation that ranges from approximately 4615 feet above mean sea level in the west to 4590 feet above mean sea level in the east, sloping gently to the east/southeast. At the time of the field investigation, the site was covered by alfalfa approximately 1-foot high.

3.2 Subsurface

A subsurface investigation was performed on April 26, 2004. Seven test pits were excavated with a Case 580 Super M backhoe to depths ranging between 9 and 12 feet. Hand-driven samples and grab samples were collected at the depths indicated on the test pit logs provided in Appendix A. The approximate test pit locations are shown on the Site Plan (Figure 1).

The subsurface soils encountered in the test pits generally consisted of fine grained soils such as silty clay (CL) and clayey silt (ML). Fine sandy silt (SM) was encountered at a depth of approximately 9 feet in TP6 and gravelly fine sand (SP) was encountered at a depth of approximately 8 feet in TP7. Some slightly porous soils were encountered in some of the test pits at a depth generally below 5 ½ feet.

3.3 Groundwater

Free water was not encountered in any of the exploratory test pits. Fluctuations in the local groundwater table may occur due to variations in surface topography, subsurface stratification, rainfall, and other factors which may not have been evident at the time of our field investigation.

3.4 Seismicity and Liquefaction

Based on a review of some available published information including the Surface Rupture and Liquefaction Potential Map of a portion of Salt Lake County, there are no faults known to pass through the site. Faults generally considered to have the most potential for earthquake damage include the generally north-south trending Granger Fault and the Taylorsville Fault which are located approximately 18 and 20 miles northeast of the site, respectively. The Wasatch Fault Zone is located about 16 miles to the east.

The proposed residential development is located within Seismic Zone 3 as defined on the Seismic Zone Map of the United States in the Uniform Building Code.

The residential development is located in an area mapped as having a "very low" potential for liquefaction.[1] The "very low" designation indicates an approximate probability of less than 5 percent that the critical ground acceleration needed to induce liquefaction would occur within a 100-year time frame. The lack of shallow groundwater and the fine grain nature of site soils would indicate the site would not likely be subject to liquefaction during an earthquake.

Although research on earthquake prediction has greatly increased in recent years, geologists and seismologists have not yet reached the point where they can predict when and where an earthquake will occur. Nevertheless, on the basis of current technology, it is reasonable to assume that the proposed structures will be subject to the effects of at least one moderate earthquake during their design life. During such an earthquake, the danger from fault offset through the site is remote, but moderate to strong ground shaking is likely to occur.

Based on a study published in the February 1996 Journal of Geophysical Research, the probability of a magnitude seven or greater earthquake occurring within the next 100 years along the Salt Lake City segment of the Wasatch Fault may be as high as 57 percent.

Listed below is a summary of seismic site categorization procedure parameters according to section 1636 of the 1997 Uniform Building Code (UBC):

Seismic Zone	3
Soil Profile Type	S_D
Seismic Source Type	B
Closest Distance to Known Seismic Source	25.7 Km
Near Source Factor N_a	1.0
Near Source Factor N_v	1.0

4. CONCLUSIONS AND RECOMMENDATIONS

From a geotechnical engineering standpoint, it is our opinion that the site is suitable for construction of the proposed residential development provided the conclusions and recommendations presented in this report are incorporated into the design and construction of the project.

Detailed earthwork and foundation recommendations are presented in the following paragraphs. The opinions, conclusions and recommendations presented in this report are contingent upon Wasatch Environmental, Inc., being retained to review the final plans and specifications as they are developed and to observe the site earthwork and installation of foundations.

4.1 Earthwork

4.1.1 Clearing and Stripping

The site should be stripped of surface vegetation and cleared of all obstructions including any unsuitable fill materials and any miscellaneous trash and debris that may be present at the time of construction. After clearing, the ground surface should be stripped of all surface vegetation. The stripping depths required to satisfactorily remove all vegetation should be determined in the field by our representative at the time of construction. The cleared and stripped materials should be disposed of off-site.

[1] Surface Rupture and Liquefaction Potential Special Study Areas Salt Lake County, Utah (Map 1:43,718)., compiled by Craig, V. Nelson, Salt Lake County Public Works, 1995.

4.1.2 Subgrade Preparation

After the site has been cleared and stripped, the exposed subgrade soils in those areas to receive fill and/or building improvements or pavements should be scarified to a depth of 8 inches, moisture conditioned, and compacted to the requirements of Item 4.1.4, "Compaction."

4.1.3 Materials for Fill

All existing on-site soils with an organic content of less than three percent by volume are suitable for use as fill. Imported fill material should be a non-expansive, granular soil with a plasticity index of 12 or less. In addition, both imported and existing on-site materials for use as fill should not contain rocks or lumps over 6 inches in greatest dimension and not more than 15 percent larger than 2-1/2 inches. Structural fill should be free of frozen materials, sod, or any other deleterious materials.

4.1.4 Compaction

All fill should be compacted to a minimum degree of compaction of 90 percent based upon ASTM Designation D-1557. Fill material should be spread and compacted in uniform horizontal lifts not exceeding 8 inches in uncompacted thickness. Before compaction begins, the fill should be brought to a water content that will permit proper compaction by either 1) aerating the fill if it is too wet, or 2) moistening the fill with water if it is too dry. Each lift should be thoroughly mixed before compaction to ensure a uniform distribution of moisture.

4.1.5 Trench Backfill

Pipeline trenches should be backfilled with compacted fill. Backfill materials should be placed in lift thicknesses appropriate to the type of compaction equipment utilized and compacted to a minimum degree of compaction of 85 percent by mechanical means. In all slab-on-grade and pavement areas, the upper portion of the backfill to a depth equal to 1.5 times the trench width, but no less than 3 feet, should be compacted to a minimum degree of compaction of 90 percent. In pavement areas, that portion of the trench backfill within the pavement section should conform to the material and compaction requirements of the adjacent pavement section.

4.1.6 Drainage

Positive surface gradients should be provided adjacent to the buildings; roof gutters and downspouts should be installed so as to direct water away from foundations and slabs toward suitable discharge facilities. Ponding of surface water should not be allowed, especially adjacent to buildings or on pavements.

4.1.7 Construction Observation

Variations in soil and geologic conditions are possible and may be encountered during construction. In order to permit correlation between the preliminary soil and geologic data and the actual conditions encountered during construction and so as to assure conformance with the plans and specifications as originally contemplated, it is essential that we be retained to perform on-site review during the course of construction.

All earthwork should be performed under the observation of our representative to assure proper site preparation, selection of satisfactory fill materials, as well as placement and compaction of the fills. Sufficient notification prior to earthwork operations is essential to make certain that the work will be properly observed.

4.2 Foundations

4.2.1 Footings

We recommend that the proposed buildings be supported on conventional, individual-spread and/or continuous footing foundations bearing on undisturbed natural soil and/or well-compacted structural fill. All exterior footings should be founded at least 30 inches below the lowest adjacent exterior grade. Interior footings should be founded a minimum of 12 inches below the lowest adjacent grade.

At the recommended depths, footings may be designed for allowable bearing pressures of 1,500 pounds per square foot (psf) for combined dead and live loads and 2,200 psf for all loads including wind or seismic. The footings should, however, have a minimum width of 12 inches. All continuous footings should contain top and bottom reinforcement to provide structural continuity and to permit spanning of local irregularities.

Settlements under building loads are expected to be within tolerable limits for the proposed structures. For footings designed in accordance with the recommendations presented in the preceding paragraphs we anticipate that post-construction differential settlements between adjacent columns and/or walls would not exceed 1-inch.

In order to assure that footings are founded on soils of sufficient load bearing capacity, it is essential that our representative inspect the footing excavations prior to the placement of reinforcing steel or concrete.

4.2.2 Lateral Loads

Lateral load resistance for footing foundations may be developed in friction between the foundation bottoms and the supporting subgrade. An allowable friction coefficient of 0.35 is considered applicable. An additional allowable passive resistance equal to an equivalent fluid weight of 350 pounds per cubic foot acting against the foundations may be used in design provided the footings are poured neat against the adjacent undisturbed native soils and/or compacted fill materials.

4.2.3 Building Floor Slabs

Concrete floor slabs should be supported on undisturbed natural soil or compacted structural fill. Slab reinforcing should be provided in accordance with the anticipated use of and loading on the slab. If it is desired to minimize hairline cracking of the slabs due to concrete shrinkage, control joints should be provided as well as providing wire mesh or fiber reinforcement in the slabs.

4.2.4 Exterior Slabs-On-Grade

Exterior slabs-on-grade may be supported on undisturbed natural soil or compacted structural fill. We recommend that consideration be given to providing a 4-inch thickness of free draining gravel beneath the slab. The gravel will help minimize the damaging effects of frost action. We recommend that the slabs be provided with control joints and be reinforced with welded wire fabric or fiber reinforcement to minimize hairline cracking of the slabs due to concrete shrinkage.

APPENDIX A

FIELD INVESTIGATION

The field investigation consisted of a surface reconnaissance and a subsurface exploration program using a Case 580 Super M backhoe. Seven exploratory test pits were excavated on April 26, 2004 at the approximate locations shown on the Site Plan, Figure 1. The soils encountered in the test pits were continuously logged in the field by our representative and described in accordance with the Unified Soil Classification System (ASTM D 2487). Logs of the test pits as well as a key for soil classification are included as part of this Appendix.

Representative samples were obtained from the exploratory test pits at selected depths appropriate to the investigation. All samples were returned to our laboratory for evaluation and testing. Hand-driven samples were collected by driving a 2-inch O.D. sleeve using a 4-pound hammer a maximum of 4-inches into the soil. Test pit log notation for the hand-driven samples as well as for grab samples are indicated below.

Hand-Driven Sample	Grab Sample
	

The test pit logs show our interpretation of the subsurface conditions on the date and at the locations indicated, and it is not warranted that they are representative of subsurface conditions at other locations and times.

The stratification lines on the test pit logs represent the approximate boundary between material types; the transition may be gradual.

KEY TO
CLASSIFICATION

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS, MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200	GRAVELS, MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVEL WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SANDS, MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	SW	Well graded sands or gravelly sands, little or not fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS, MORE THAN HALF OF MATERIAL IS SMALLER	SILTS AND CLAYS, LIQUID LIMIT IS LESS THAN 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS, LIQUID LIMIT IS GREATER THAN 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils.

DEFINITION OF TERMS

	U.S. STANDARD SERIES SIEVE			CLEAR SQUARE SIEVE OPENINGS		
	200	40	10	4	3/4"	3"	12"

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COURSE	FINE	COURSE		

GRAIN SIZES

SANDS, GRAVELS AND NON-PLASTIC SILTS	BLOWS/FOOT[1]
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

RELATIVE DENSITY

CLAYS AND PLASTIC SILTS	STRENGHT[2]	BLOWS/FOOT[1]
VERY SOFT	0 - ¼	0 - 2
SOFT	¼ - ½	2 - 4
FIRM	½ - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

CONSISTENCY

[1]Number of blows of 140 pounds hammer falling 30 inches to drive a 2-inch O.D. (1-3/8-inch I.D.) Split spoon (ASTM D-1586)

[2]Unconfined compressive strength in tons/sq.ft. As determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

WASATCH ENVIRONMENTAL, INC.

M:/forms/Key for Classification

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487

McMillan Property
Approx. 12200 South Thunder Road
Riverton, UT

PROJECT NO.	DATE	
1508-11	5/18/04	FIGURE A-1

DATE EXCAVATED:	APRIL 26, 2004
LOGGED BY:	VJ
REFERENCE ELEVATION:	--
BACKHOE/TRACKHOE:	CASE 580 SUPER M EXTENDAHOE
TOTAL DEPTH:	11'
DEPTH TO GROUNDWATER:	NOT ENCOUNTERED

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE	DEPTH (FEET)	SAMPLER	BLOWS/FOOT	WATER CONTENT (%)	DRY DENSITY (pcf)	PASSING 200 SIEVE (%)	OTHER
Silty CLAY, moist ↑Top-soil	Brown	Stiff	CL	1						
Clayey SILT, moist	Brown	Firm	ML	2	*					
				3						
				4						
very moist		Soft		5			34.2	73.4	99.1	
				6						
				7	*					
				8						
				9						
	Very Dark Brown	Firm		10	*					

WASATCH ENVIRONMENTAL, INC.

TEST PIT

MCMILLAN PROPERTY
12200 SOUTH THUNDER ROAD
RIVERTON, UT

PROJECT NO.: 1508-11 | TEST PIT NO.: 1

DATE EXCAVATED:	APRIL 26, 2004
LOGGED BY:	VJ
REFERENCE ELEVATION:	--
BACKHOE/TRACKHOE:	CASE 580 SUPER M EXTENDAHOE
TOTAL DEPTH:	10'
DEPTH TO GROUNDWATER:	NOT ENCOUNTERED

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE	DEPTH (FEET)	SAMPLER	BLOWS/FOOT	WATER CONTENT (%)	DRY DENSITY (pcf)	PASSING 200 SIEVE (%)	OTHER
Clayey SILT, moist ↑Top-soil	Very Dark Brown Dark Brown	Firm	ML	1 2 3 4 5 6 7 8 9			27.0	76.3	96.8	
Clayey SILT, slightly porous, moist	Gray	Stiff	ML		*					

WASATCH ENVIRONMENTAL, INC.

TEST PIT

MCMILLAN PROPERTY
12200 SOUTH THUNDER ROAD
RIVERTON, UT

PROJECT NO.: 1508-11 | TEST PIT NO.: 2

DATE EXCAVATED:	APRIL 26, 2004
LOGGED BY:	VJ
REFERENCE ELEVATION:	--
BACKHOE/TRACKHOE:	CASE 580 SUPER M EXTENDAHOE
TOTAL DEPTH:	9 1/2'
DEPTH TO GROUNDWATER:	NOT ENCOUNTERED

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE	DEPTH (FEET)	SAMPLER	BLOWS/FOOT	WATER CONTENT (%)	DRY DENSITY (pcf)	PASSING 200 SIEVE (%)	OTHER
Clayey SILT, moist ↑Top-soil	Brown	Firm	ML	1 2 3 4 5 6	*		27.0	75.6	86.4	
Clayey SILT, slightly porous, moist	Gray	Stiff	ML	7 8 9	* *					

WASATCH ENVIRONMENTAL, INC.

TEST PIT

MCMILLAN PROPERTY
12200 SOUTH THUNDER ROAD
RIVERTON, UT

PROJECT NO.: 1508-11 | TEST PIT NO.: 3

DATE EXCAVATED:	APRIL 26, 2004
LOGGED BY:	VJ
REFERENCE ELEVATION:	--
BACKHOE/TRACKHOE:	CASE 580 SUPER M EXTENDAHOE
TOTAL DEPTH:	12'
DEPTH TO GROUNDWATER:	NOT ENCOUNTERED

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE	DEPTH (FEET)	SAMPLER	BLOWS/FOOT	WATER CONTENT (%)	DRY DENSITY (pcf)	PASSING 200 SIEVE (%)	OTHER
Clayey SILT, moist ↑Top-soil	Dark Brown	Firm	ML	1 2 3 4	* 4		30.7	77.6	96.6	
less plastic than above, slightly porous	Light Gray	Stiff		5 6 7 8 9 10 11	* * *					

WASATCH ENVIRONMENTAL, INC.

TEST PIT

MCMILLAN PROPERTY
12200 SOUTH THUNDER ROAD
RIVERTON, UT

PROJECT NO.: 1508-11 | TEST PIT NO.: 4

DATE EXCAVATED:	APRIL 26, 2004
LOGGED BY:	VJ
REFERENCE ELEVATION:	--
BACKHOE/TRACKHOE:	CASE 580 SUPER M EXTENDAHOE
TOTAL DEPTH:	9'
DEPTH TO GROUNDWATER:	NOT ENCOUNTERED

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE	DEPTH (FEET)	SAMPLER	BLOWS/FOOT	WATER CONTENT (%)	DRY DENSITY (pcf)	PASSING 200 SIEVE (%)	OTHER
Silty CLAY, moist ↑Top-soil	Dark Brown	Stiff	CL	1						
Clayey SILT, moist	Brown	Firm	ML	2						
				3			27.1	74.6	98.5	
				4						
		Stiff		5	*					
				6	*					
				7						
	Gray	Stiff-Very Stiff		8						
					*					

WASATCH ENVIRONMENTAL, INC.

TEST PIT

MCMILLAN PROPERTY
12200 SOUTH THUNDER ROAD
RIVERTON, UT

PROJECT NO.: 1508-11 | TEST PIT NO.: 5

DATE EXCAVATED:	APRIL 26, 2004
LOGGED BY:	VJ
REFERENCE ELEVATION:	--
BACKHOE/TRACKHOE:	CASE 580 SUPER M EXTENDAHOE
TOTAL DEPTH:	9 1/2'
DEPTH TO GROUNDWATER:	NOT ENCOUNTERED

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE	DEPTH (FEET)	SAMPLER	BLOWS/FOOT	WATER CONTENT (%)	DRY DENSITY (pcf)	PASSING 200 SIEVE (%)	OTHER
Silty CLAY, moist ↑Top-soil	Brown	Stiff	CL	1	*					
				2						
Clayey SILT, moist	Brown	Firm-Stiff	ML	3						
				4	*					
slightly porous	Gray	Stiff		5						
				6			26.6	79.0	98.1	
				7						
				8						
Fine Sandy SILT, moist	Gray	Medium Dense	SM	9	*					

WASATCH ENVIRONMENTAL, INC.

TEST PIT

MCMILLAN PROPERTY
12200 SOUTH THUNDER ROAD
RIVERTON, UT

PROJECT NO.: 1508-11 | TEST PIT NO.: 6

DATE EXCAVATED:	APRIL 26, 2004
LOGGED BY:	VJ
REFERENCE ELEVATION:	--
BACKHOE/TRACKHOE:	CASE 580 SUPER M EXTENDAHOE
TOTAL DEPTH:	10'
DEPTH TO GROUNDWATER:	NOT ENCOUNTERED

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE	DEPTH (FEET)	SAMPLER	BLOWS/FOOT	WATER CONTENT (%)	DRY DENSITY (pcf)	PASSING 200 SIEVE (%)	OTHER
Clayey SILT, moist ↑Top-soil	Brown	Firm	ML	1						
				2						
				3						
Silty CLAY, moist	Brown	Firm	CL	4			31.6	78.3	87.6	
				5						
Clayey SILT, moist	Gray	Stiff	ML	6						
				7						
				8						
Gravelly Fine SAND, minor silt, angular to sub-angular Gravel, average Gravel diameter ~1", occasional cobbles, moist	Gray	Medium Dense	SP	9	*					

WASATCH ENVIRONMENTAL, INC.

TEST PIT

MCMILLAN PROPERTY
12200 SOUTH THUNDER ROAD
RIVERTON, UT

PROJECT NO.: 1508-11 | TEST PIT NO.: 7